

CLAIMS

1. A pipette module comprising:  
a channel block having at least one cylindrical passage extending therethrough;  
5 a rod sized, shaped and aligned to pass into the cylindrical passage;  
a cylinder having an axially extending passage therethrough sized, shaped and  
aligned to pass into the cylindrical passage from the end opposite the end into which the  
rod passes;  
a chamber defined by the channel block, rod, and cylinder, having a volume  
10 which is variable, with a first part of the chamber variable by relative movement of the  
channel block relative to the fixed relative positions of the rod and cylinder, and with a  
second part of the chamber variable by relative movement of the cylinder relative to the  
fixed relative positions of the rod and channel block.
- 15 2. The pipette module of claim 1, wherein a third part of the chamber is  
variable by relative movement of the rod relative to the fixed relative positions of the  
channel block and cylinder.
- 20 3. The pipette module of claim 1, wherein the diameter of the rod is greater  
than the diameter of the cylinder, providing an annular space between the inner surface  
of the channel block and the outer surface of the cylinder, defining said first part of the  
chamber.
- 25 4. The pipette module of claim 3, wherein the diameter of the rod is less than  
the inner diameter of the channel block, providing an annular space between the inside  
surface of the channel block and the outside surface of the rod, defining said third part of  
the chamber.
- 30 5. The pipette of claim 1, further comprising:  
a tip having a passageway therethrough, extending downwardly from the bottom  
of the cylinders; and

an extension mandrel with a passageway extending therethrough, the mandrel attached at an end of the cylinder such that the passageway extending through the mandrel is aligned with the cylinder passageway, wherein the mandrel reduces the internal volume within the tip.

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6. The pipette of claim 5, wherein the extension mandrel is removably secured to the cylinder.

7. A pipette module comprising:  
10 a channel block with a plurality of parallel cylindrical passages;  
a rod plate, having a plurality of cylindrical rods, sized, shaped, and aligned to pass into corresponding cylindrical passages from the top thereof on vertical relative movement of the channel block or the rod plate;  
a cylinder plate, having a plurality of cylinders with axially extending passages  
15 therethrough, sized, shaped, and aligned to pass upwardly into the corresponding cylinder passages in the channel block, with the diameter of the rods and cylinders different;  
and a plurality of tips having passages therethrough, extending downwardly from the bottoms of the cylinders.

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8. The pipette module of claim 7, wherein the diameter of the rods are greater than the diameter of the cylinders, providing an annular space between an inner surface of the channel block and an outer surface of the cylinder.

25 9. The pipette module of claim 8, further comprising a plurality of chambers positioned within the channel block passages, the volumes of which are defined in part by the relative position of the rods and the channel block; and  
wherein each chamber has a first portion defined by the space between the inner surface of the channel block and the outer surface of the cylinder, and a second portion  
30 defined by a space between an end of the rod and an adjacent end of the cylinder.

10. The pipette module of claim 9, wherein movement of the channel block relative to the cylinder plate varies the volume in the first portion of the chamber, and movement of the rod plate and the channel block relative to the cylinder plate varies the volume in the second portion of the chamber.

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11. The pipette module of claim 9, wherein each chamber has a third portion defined by a space between the inner surface of the channel block and an outer surface of the rod.

10 12. The pipette module of claim 10, wherein movement of the channel block relative to the cylinder plate varies the volume in the first portion and the third portion of the chamber.

13. The pipette module of claim 10, wherein the multiplying factor between  
15 the cross-sectional area of the first portion of the chamber and the second portion of the chamber is at least 100.

14. The pipette module of claim 9, wherein the chamber is provided with a first and second sealing means for forming two ends of the chamber, the first sealing  
20 means is fixed to the channel plate and is axially movable with the channel relative to the rods, the second sealing means is fixed to the channel plate and is axially movable with the channel relative to the cylinders.

15. The pipette module of claim 7, further comprising a rack for holding the  
25 plurality of tips.

16. The pipette module of claim 15, wherein the plurality of tips are disposable and removable from the rack.

30 17. The pipette module of claim 15, wherein the rack is disposable.

18. The pipette module of claim 7, further comprising an extension mandrel with a passageway extending therethrough, the mandrel attaching to an end of the cylinder, so that the passageway extending through the mandrel is aligned with the cylinder passageway, wherein the mandrel reduces the internal volume within the tip.

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19. The pipette module of claim 18, wherein the internal volume within the tip is reduced by a volume equal to the volume of the mandrel.

20. The pipette module of claim 7, wherein there are 96 cylindrical passageways that correspond with 96 rods and 96 cylinders.

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21. The pipette module of claim 7, wherein there are 384 cylindrical passageways that correspond with 384 rods and 384 cylinders.

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22. The pipette module of claim 10, further comprising:  
a motor to control the movement of the channel block relative to the cylinder plate.

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23. The pipette module of claim 22, further comprising:  
at least one helical spring to control the movement of the rod plate relative to the cylinder plate.

24. The pipette module of claim 7, in combination with a working module for the placement and movement of the channel block, rod plate, or cylinder plate of the pipette module, wherein the working module comprises:

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alignment bearings to position the channel block, rod plate, or cylinder plate of the pipette module for smooth axial movement;

a motor communicating with the pipette module to initiate movement of channel block, rod plate, or cylinder plate of the pipette module; and

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a position sensor to sense the location of at least one of the channel block, rod plate, or cylinder plate.

25. The pipette module of claim 24, in combination with the working module, wherein the working module further comprises:

5 electronic controls and a communication port in connection with the alignment bearings, motor, and position sensor, to control the movement of at least one of the channel block, rod plate, or cylinder plate.

26. The pipette module of claim 25, in combination with the working module, wherein the working module further comprises:

10 conveyor means to transfer microplates, test tubes, or pipette tips to and from the pipette module.

27. The pipette module of claim 7, further comprising a hanging ledge movable with the rod plate and a ledge gripper movable with the channel block, wherein  
15 vertical movement of the ledge gripper and the channel block initiates movement of the hanging ledge and the rod plate upon contact between the ledge gripper and the hanging ledge.

28. An air-filled pipette for metering volumes of fluid comprising:  
20 a cylinder with an elongated passageway therethrough;  
a channel block concentric with and movable relative to the cylinder and at least in part defining an air-filled chamber at one end of the cylinder, the cylinder having an outer surface at least in part spaced from an inner surface of the channel block;  
a rod positioned and longitudinally movable in and out of the channel block, the  
25 rod sized and shaped to occupy selected volumes of the chamber;  
sealing means forming two ends of the chamber, said sealing means fixed to the inner surface of the channel block and movable relative to either the rod or the cylinder;  
a tip having a passageway therethrough, extending downwardly from the bottom of the cylinder; and  
30 an extension mandrel with a passageway extending therethrough, the mandrel attaching to an end of the cylinder, so that the passageway extending through the

mandrel is aligned to correspond with the elongated passageway in the cylinder, wherein the mandrel reduces the volume within the tip.

29. The air-filled pipette of claim 28, wherein the extension mandrel is  
5 removably secured to the cylinder.

30. The pipette module of claim 28, wherein volume within the tip is reduced by a volume equal to the volume of the mandrel.

10 31. A method of metering multiple fluid samples with a pipette having a tip defining a fixed volume, comprising:  
attaching a removable mandrel to a portion of the pipette within the tip, wherein the internal volume of the tip is reduced;  
introducing a pipette tip into a reservoir of a fluid sample;  
15 aspirating a quantity of the fluid sample into the pipette tip by increasing the volume of an air-filled chamber within the pipette; and  
dispensing the fluid sample out of the pipette tip by decreasing the volume of the air-filled chamber.

20 32. The method of claim 31, wherein the volume within the tip is reduced by a volume equal to the volume of the mandrel.

33. The method as set forth in claim 31, further comprising:  
aspirating a second smaller quantity of a fluid sample into the pipette tip by  
25 increasing the volume of an air-filled chamber within the pipette, whereby the accuracy of the aspiration of the second quantity is increased due to a reduction in the volume of air within the chamber.

34. The method of claim 33, further comprising:  
30 removing the mandrel from the pipette to increase the internal volume of the tip;

aspirating a third larger quantity of a fluid sample into the pipette tip by increasing the volume of an air-filled chamber within the pipette.

35. A method for increasing the accuracy of metering a fluid sample with an  
5 air-filled pipette comprising:

adding a removable attachment to the tip to reduce the internal volume of a tip, whereby the volume of air that may compress or expand during aspiration is decreased.

36. A method of mixing multiple fluid samples within a pipette, comprising:  
10 aspirating a first quantity of a fluid sample into an end of a pipette tip, wherein the pipette tip is sized and shaped such that the cross-sectional area of the tip for receiving fluid, increases in a direction away from the end of the tip;  
aspirating a first quantity of air into the pipette tip;  
aspirating a second quantity of a fluid sample into the pipette tip;  
15 aspirating a second quantity of air into the pipette tip, wherein the first and second quantities of the fluid sample move farther into the pipette tip, away from the end of the tip, such that the cross-sectional of both the first and the second fluid sample increases, thereby decreasing the thickness of each fluid sample; wherein the second quantity of air is aspirated into the pipette tip until one of the fluid samples within the  
20 pipette becomes membranous and breaks its continuity, thereby mixing with the other fluid sample; and  
dispensing the mixed first and second fluid sample from the pipette tip.

37. The method of claim 36, further comprising:  
25 oscillating the mixture of the first and second sample up and down within the pipette to further mix the samples together, prior to the dispensing step.

38. The method of claim 36, wherein the first fluid sample is a different type of fluid from the second fluid sample.

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39. The method of claim 36, wherein the second fluid sample is smaller than the first fluid sample.

5 40. A pipette in combination with a removable pipette tip, wherein the pipette comprises:

a main body portion of the pipette; and

an extension mandrel located at one end of the main body portion of the pipette, wherein the cross-sectional area of the extension mandrel is less than the cross-sectional area of the main body portion of the pipette, such that when a removable pipette tip is  
10 secured to the end of the pipette, the extension mandrel fills a volume within the pipette tip that the main body portion of the pipette alone would not be capable of filling.

41. The pipette of claim 40, in combination with a removable pipette tip, wherein the extension mandrel is removably secured to the main body portion of the  
15 pipette.

42. The pipette of claim 40, in combination with a removable pipette tip, wherein the main body portion of the pipette transitions to the extension mandrel in a step arrangement.  
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43. The pipette of claim 40, in combination with a removable pipette tip, wherein the removable pipette tip contacts both the main body portion of the pipette, and the extension mandrel when the removable pipette tip is secured to the pipette.

25 44. The pipette of claim 40, in combination with a removable pipette tip, wherein the removable pipette tip contacts the pipette at least at two distinct locations on the pipette when the removable pipette tip is secured to the pipette.

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